STEP for Electronics

Boeing Space & Communications Group

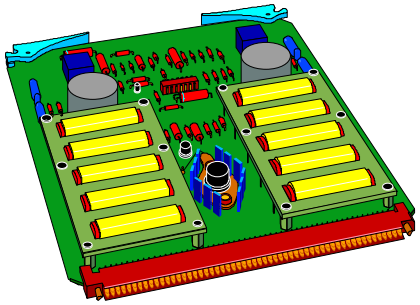
Gregory L. Smith

NASA's STEP for Aerospace Workshop

At

Jet Propulsion Laboratory

Pasadena, CA



January 25th, 2000

Agenda

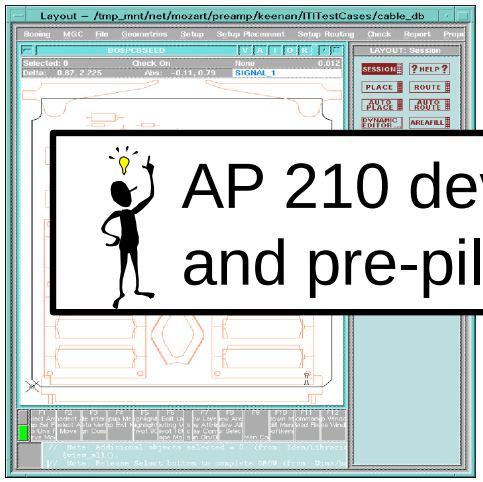
- AP 210 Development
- Past AP 210 Activities
- Present AP 210 Activities
- Future AP 210 Activities
- Questions & Answers

Boeing - STEP for Electronics

Space & Communications — *Electronics Computing Support*

AP 210 development and pre-pilot activities.

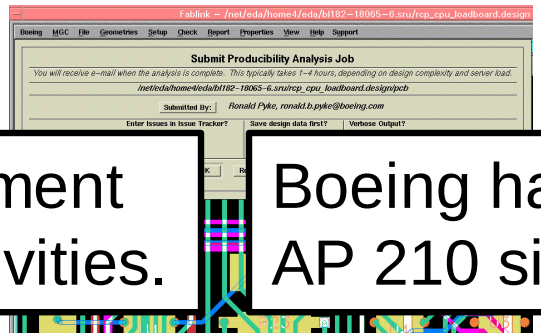
Boeing has been working on AP 210 since its inception.



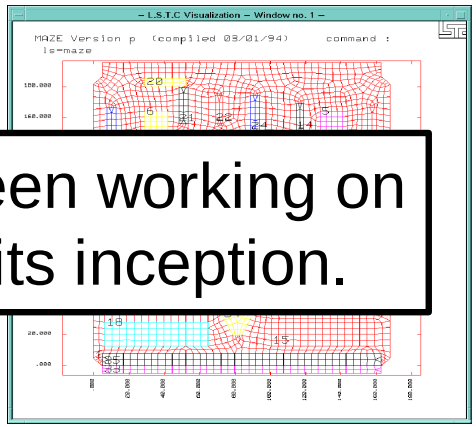
Design

Mentor To/From AP 210

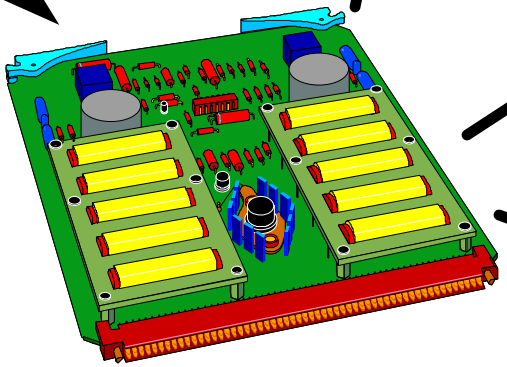
AP 210 To Producibility Analysis

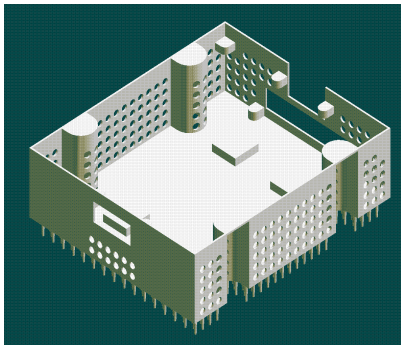


AP 210 To Durability Analysis



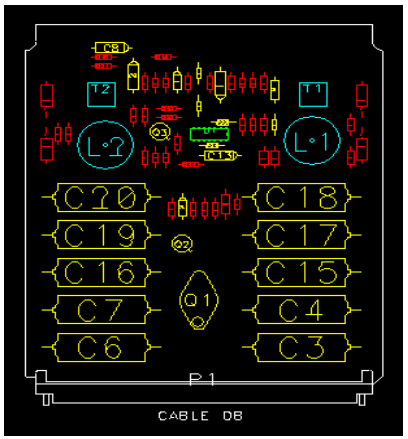
Analysis





AP 210 To/From Mechanical

Future

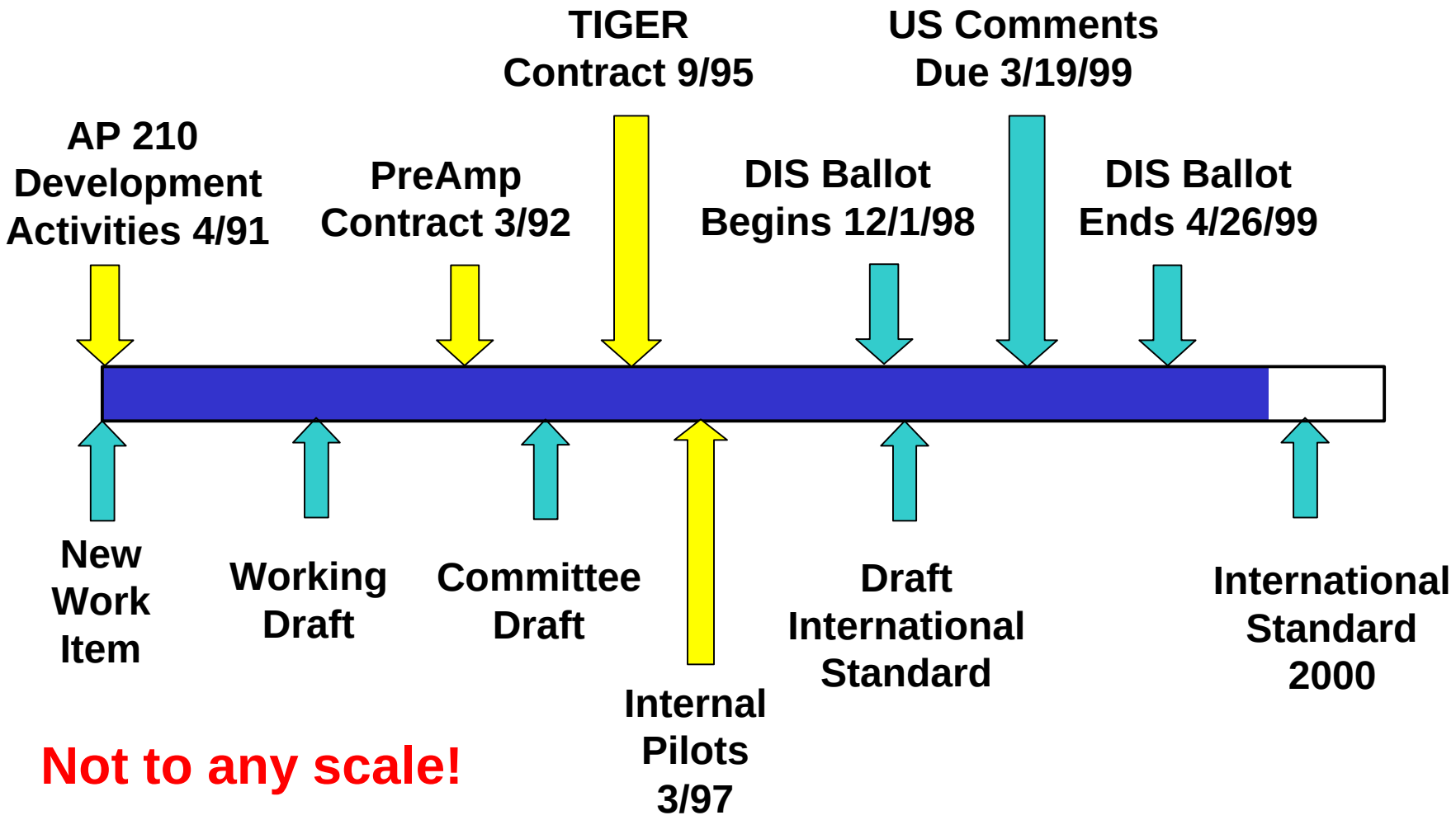


AP 210

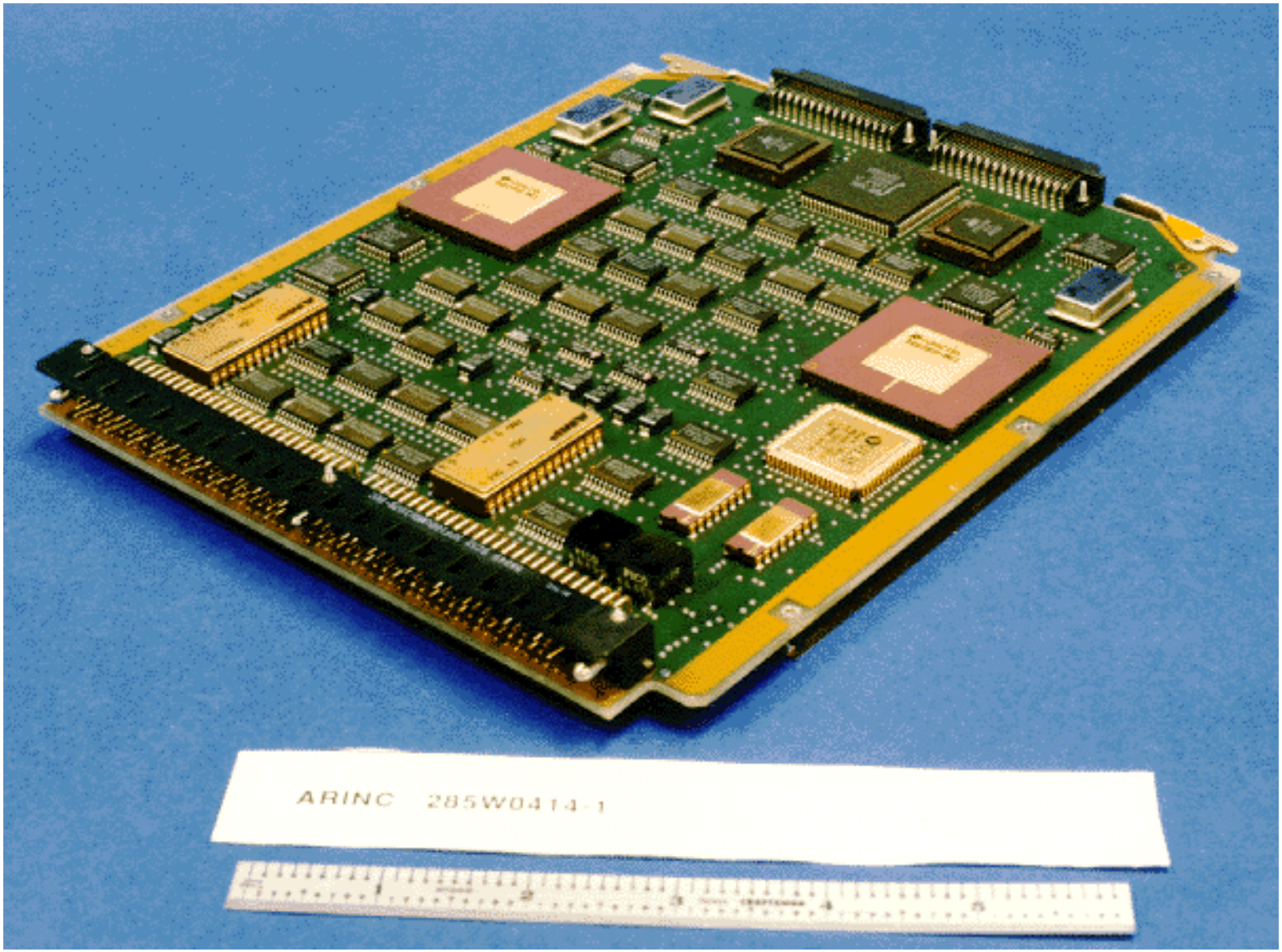
Mechanical

Manufacturing

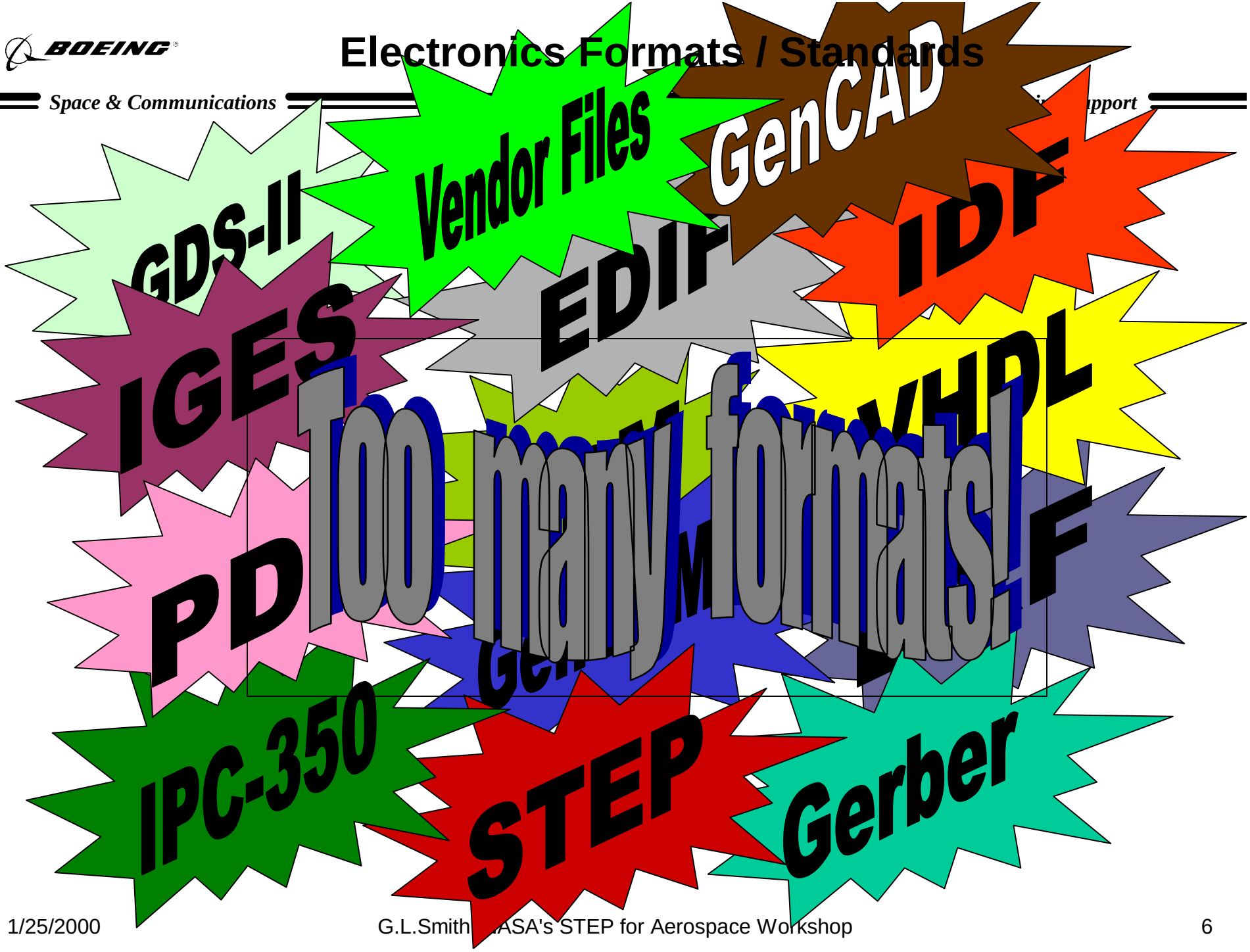
STEP AP 210 Activities Timeline



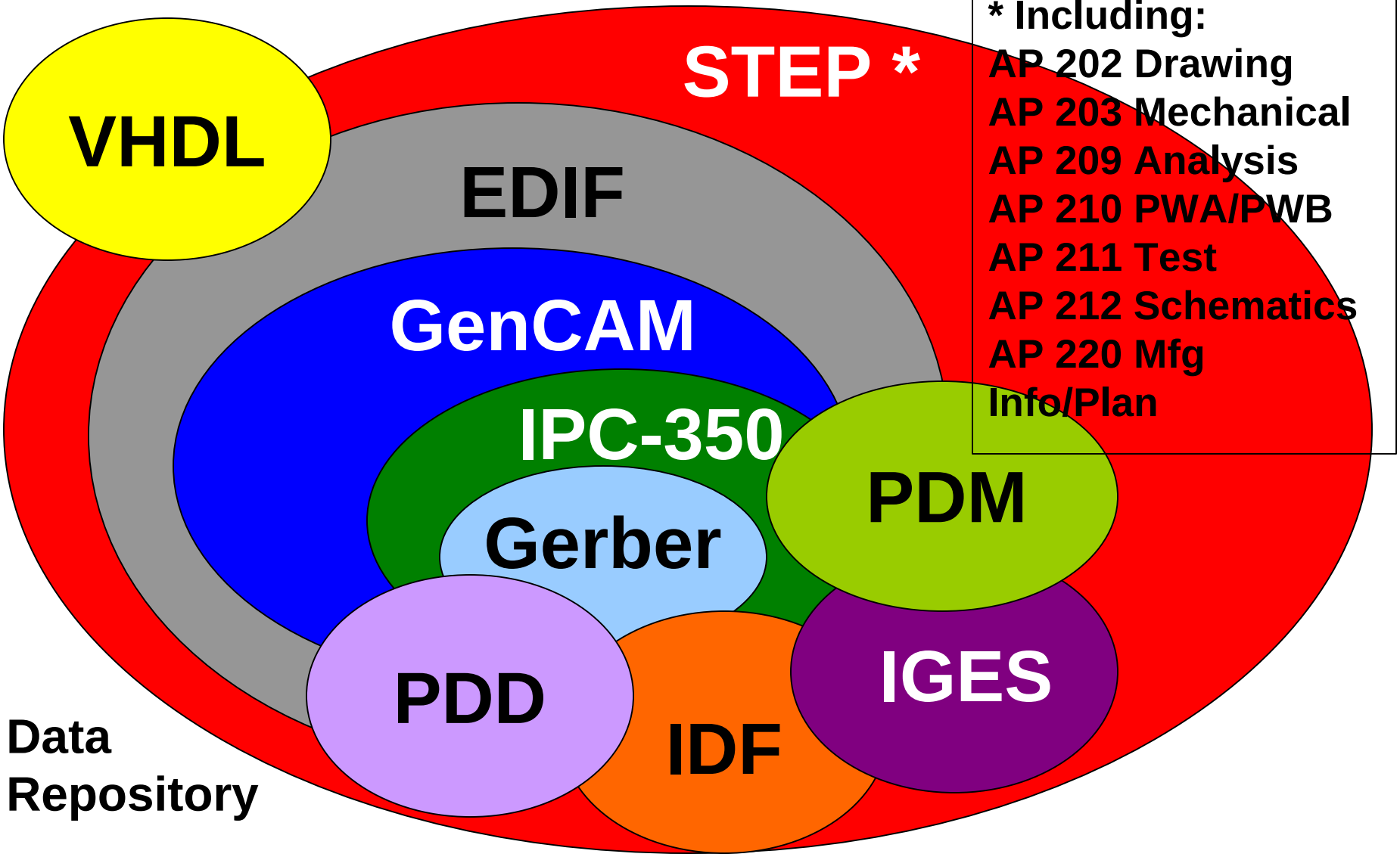
Sample PWA from 777



Electronics Formats / Standards



A (Very) Rough Comparison of Standards

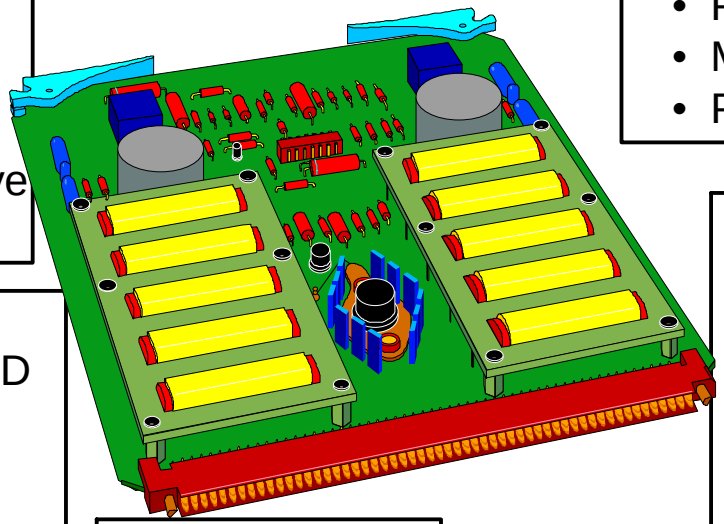


Electrical Assembly Interconnect and Packaging Design

Physical
- Component Placement
- Bare Board Design
- Layout templates
- Layers non-planar, conductive & non-conductive
- Material product

Product Structure/ Connectivity
- Functional
- Packaged

Part
- Functionality
- Analysis Support
- Shape 2D, 3D
- Package
- Material Product
- Properties



Geometry
- Geometrically Bounded 2-D
- Wireframe with Topology
- Surfaces
- Advanced BREP Solids
- Constructive Solid Geometry

Configuration Mgmt
- Identification
- Authority
- Effectivity
- Control
- Requirement Traceability
- Analytical Model
- Document References

Requirements
- Design
- Allocation
- Constraints
- Interface
- Rules

Design Control
- Geometric Dimensioning and Tolerancing

Technology
- Fabrication Design Rules
- Product Design Rules

Pre Competitive Advanced Manufacturing Processes

- Contract Sponsor: NIST Advanced Technology Program.
- Timeframe: Mar 1992 - Sep 1995.
- Members:
  - **Rockwell** **Martin Marietta** **Boeing** **ADL**
  - **Hughes** **Step Tools, Inc.** **Digital** **Battelle**
  - **SCRA**
- Results:
  - **Software framework for defining and executing rules using AP 210 and AP 220 as the source of data.**
  - **Facility for defining manufacturing resources.**
  - **Mentor to AP 210 Translator.**
  - **Initial examination and analysis of AP 210.**
- Standards Used: CD version of AP 210
  WD version of AP 220

Team Integrated - Electronic Response

- Contract Sponsor: DARPA program.
- Timeframe: Sep 1995 - Mar 1997.
- Members:
  - **Boeing (Seattle & Irving)** **Georgia Tech** **ITI**
  - **Holaday Circuits, Inc.** **SCRA** **ADL**
- Results:
  - **Enhanced translator, rules definition and execution facilities.**
  - **Negotiation facility.**
  - **Integration with thermal analysis tools.**
  - **Web access to tools.**
  - **Methodology for rules execution (administration, data extraction, data analysis).**
  - **Encoded numerous rules to test system concepts.**
- Standards Used: DIS WD1 version of AP 210

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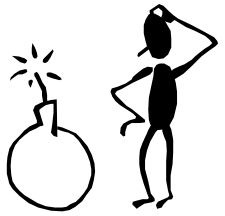
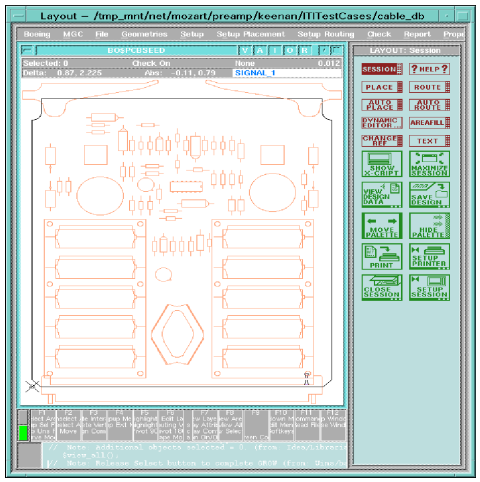
Boeing (working w/ Delco)
is supporting the development
of AP 210 translation.

- Mentor To/From AP 210





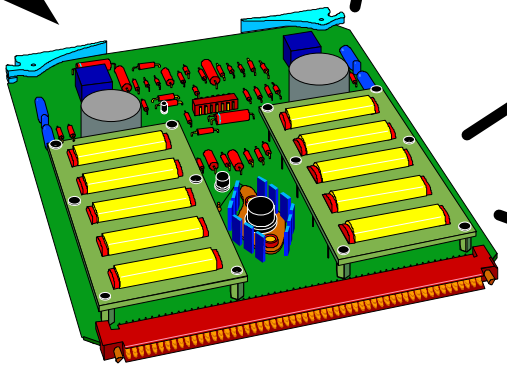
Design

Mentor
To/From
AP 210

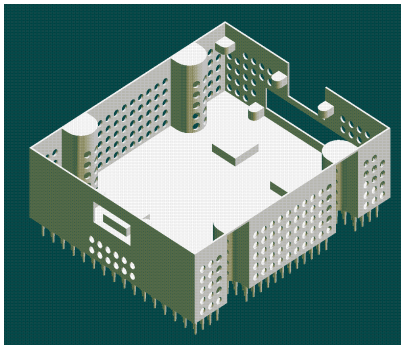
AP 210
To
Producibility
Analysis

AP 210
To
Durability
Analysis

Analysis



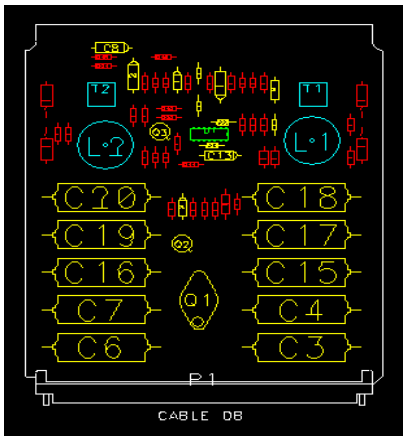
AP 210



Mechanical

AP 210
To/From
Mechanical

Future



Manufacturing

Mentor to AP 210 Translator

Objectives:

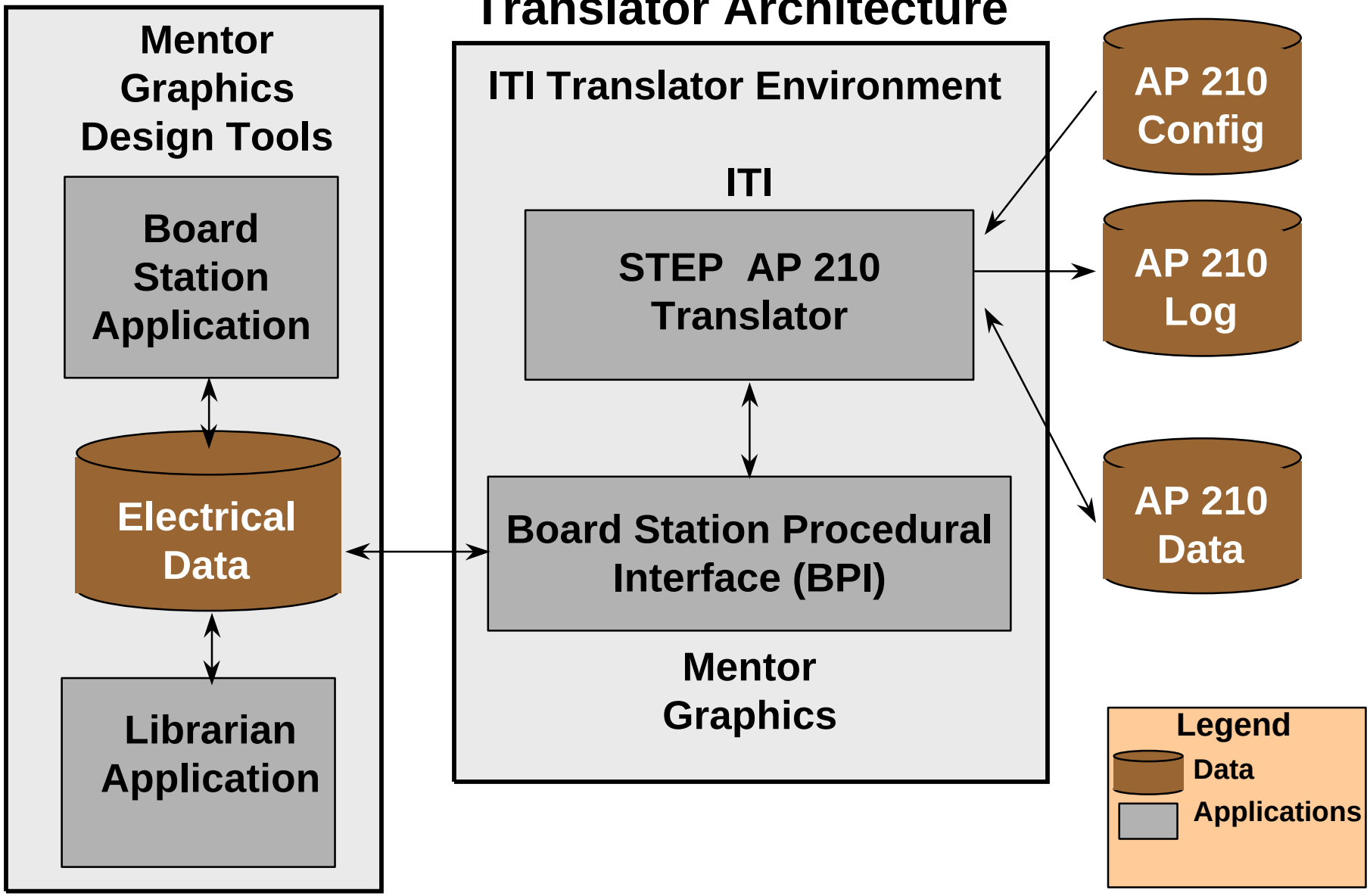
- **Achieve a seamless data flow within Printed Wiring Board and Assembly (PWB/PWA) Define/Produce processes.**
- **Deploy a vendor independent mechanism to share PWB/PWA data within Boeing, with customers and suppliers.**

Approach:

- **Support development of the STEP AP 210 standard.**
- **Acquire a commercial bi-directional STEP DIS AP 210 translator from International TechneGroup Incorporated (ITI):**
  - **Version A (Oct 98)**
  - **Version B (Jun 99)**
  - **Pilot (Dec 99)**
  - **Production (1Q 00)**
- **Work with Define/Produce centers to pilot the AP 210 translator.**
- **Involve other companies as appropriate:**
  - **Delphi Delco Electronics**

Mentor to AP 210 Translator

Translator Architecture



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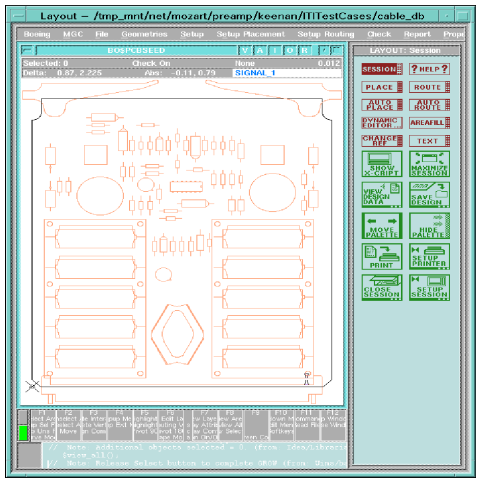
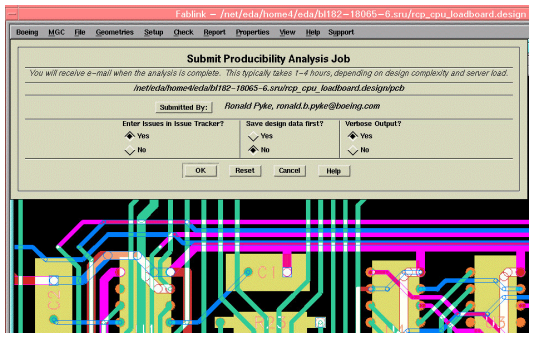


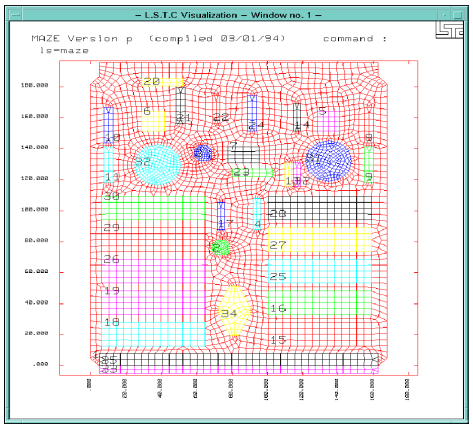
Design

Mentor To/From AP 210

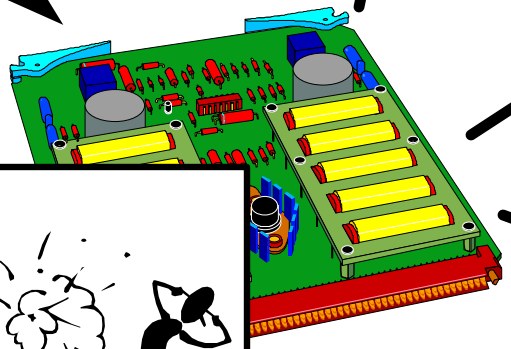


AP 210 To Producibility Analysis

AP 210 To Durability Analysis



Analysis



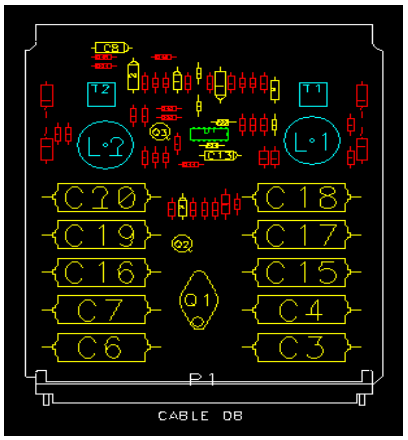
Boeing is presently deploying AP 210 on several internal projects:

- Durability Analysis

Mechanical

P 210

Future



Manufacturing

Durability Analysis

Objectives:

- **Integrate the electrical PWA design and durability analysis processes to improve quality and reduce flow time.**
- **Enable designers to introduce structural members such as ribs/stiffeners and/or covers during PWA layout for design optimization.**
- **Develop methods for predicting fatigue life due to vibration and acoustic pressure field environments.**

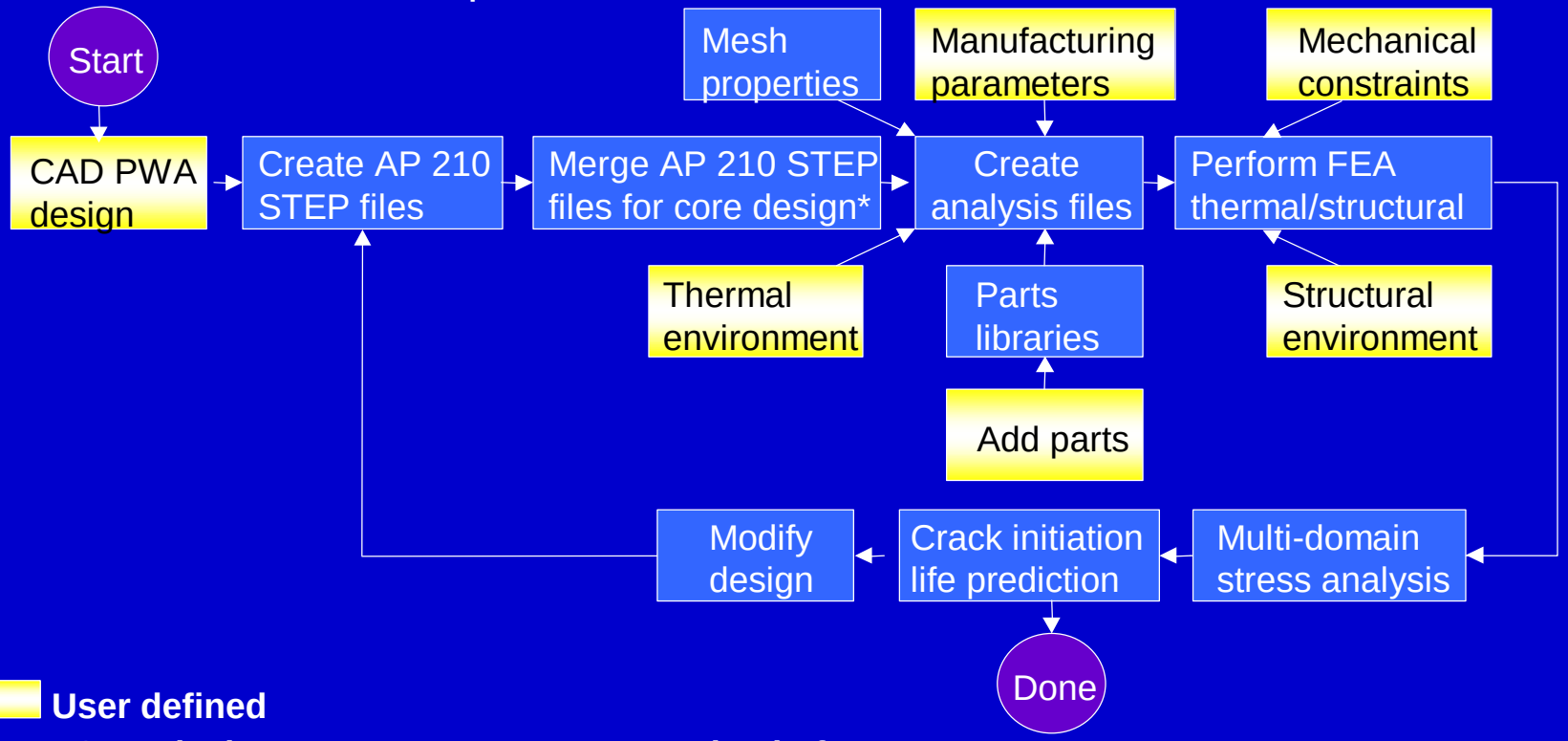
Approach:

- **Use STEP AP 210 standard to transfer PWA design geometry and material definition.**
- **Develop capabilities to assess durability of printed wiring assembly (PWA) by physics-of-failure method.**
- **Use and modify public domain codes validated with COTS.**
- **Provide an integrated process on the designers desktop.**

Durability Analysis

Durability Analysis Process for Environment Modeling

- Low-cycle fatigue
- High-cycle fatigue
- Acoustic pressure

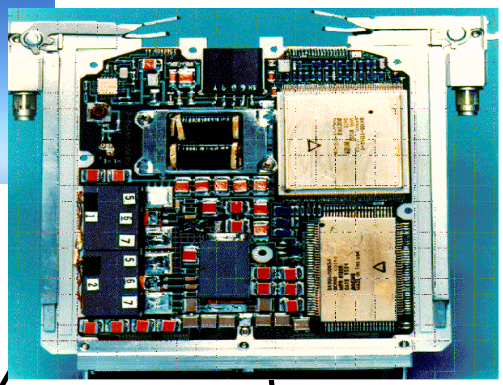


User defined

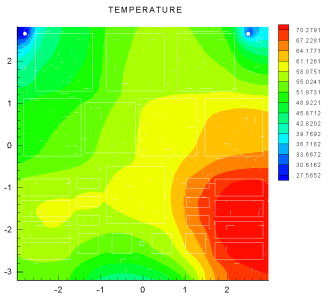
*** Core design represents a PWA comprised of a metallic plate used to conduct heat**

Durability Analysis

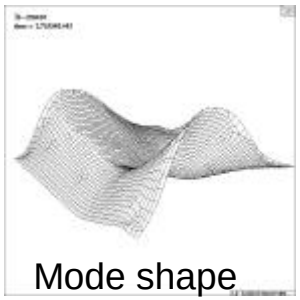
Integrated Tools



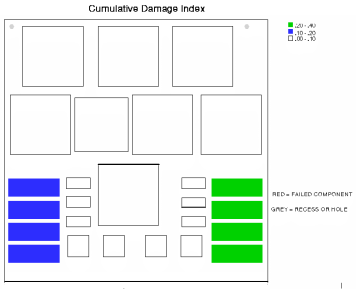
Thermal Analysis



Vibration Analysis



Failure Assessment



- A metric to identify a failure mechanism and predict time to failure
- Provides assessment of vendor PWAs
- Reduces cost of products by concurrent engineering

Durability Analysis

Benefits:

- **Error reductions, elimination of duplicate data entry.**
- **Improved quality and flow time, reduced design iterations due to errors.**
- **Concurrent engineering by allowing flow of data between electrical and analytical modules.**

Targeted Applications:

- **Numerous Boeing projects**

Technology Available:

- **June 1999**

Expected Savings When Implemented on Target Applications:

- **3000 engineering hours per year***

***Estimate only - Boeing is not to be contractually held to this number!**

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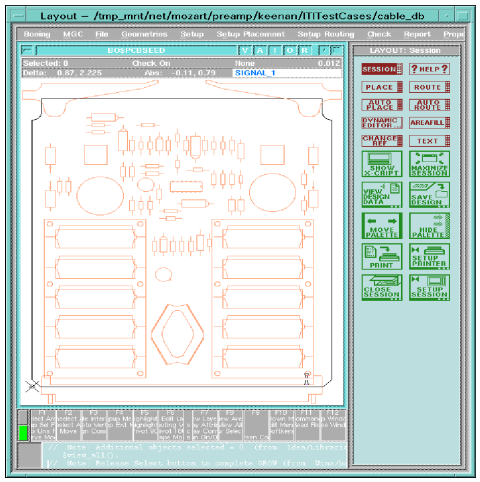
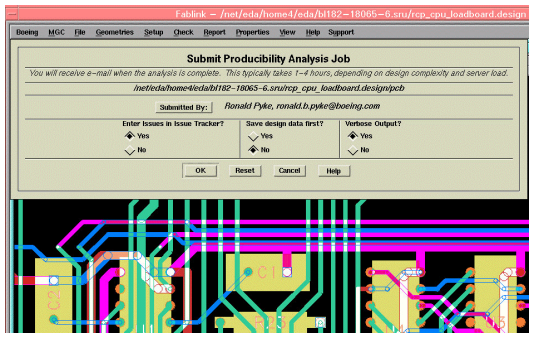


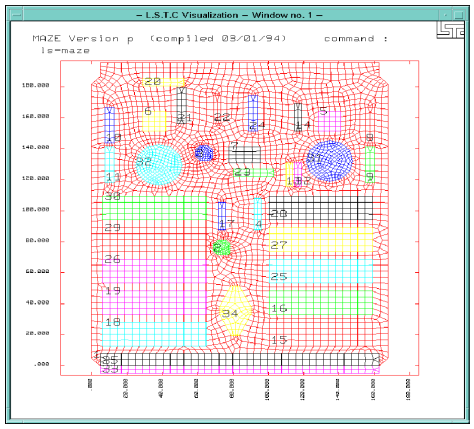
Design

Mentor To/From AP 210

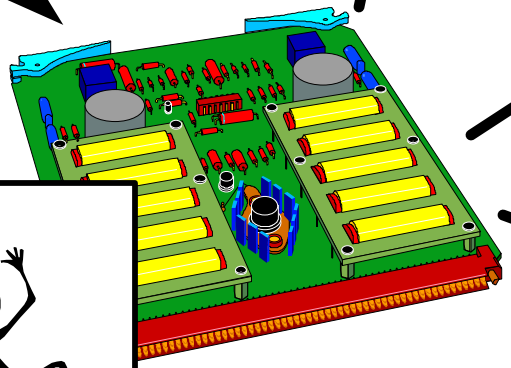


AP 210 To Producibility Analysis

AP 210 To Durability Analysis

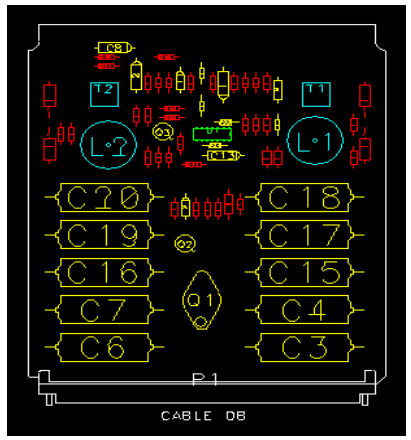


Analysis



AP 210

Future



Manufacturing

Boeing is presently Deploying AP 210 on several internal projects:

- Producibility Analysis

Mechanical

Producibility Analysis

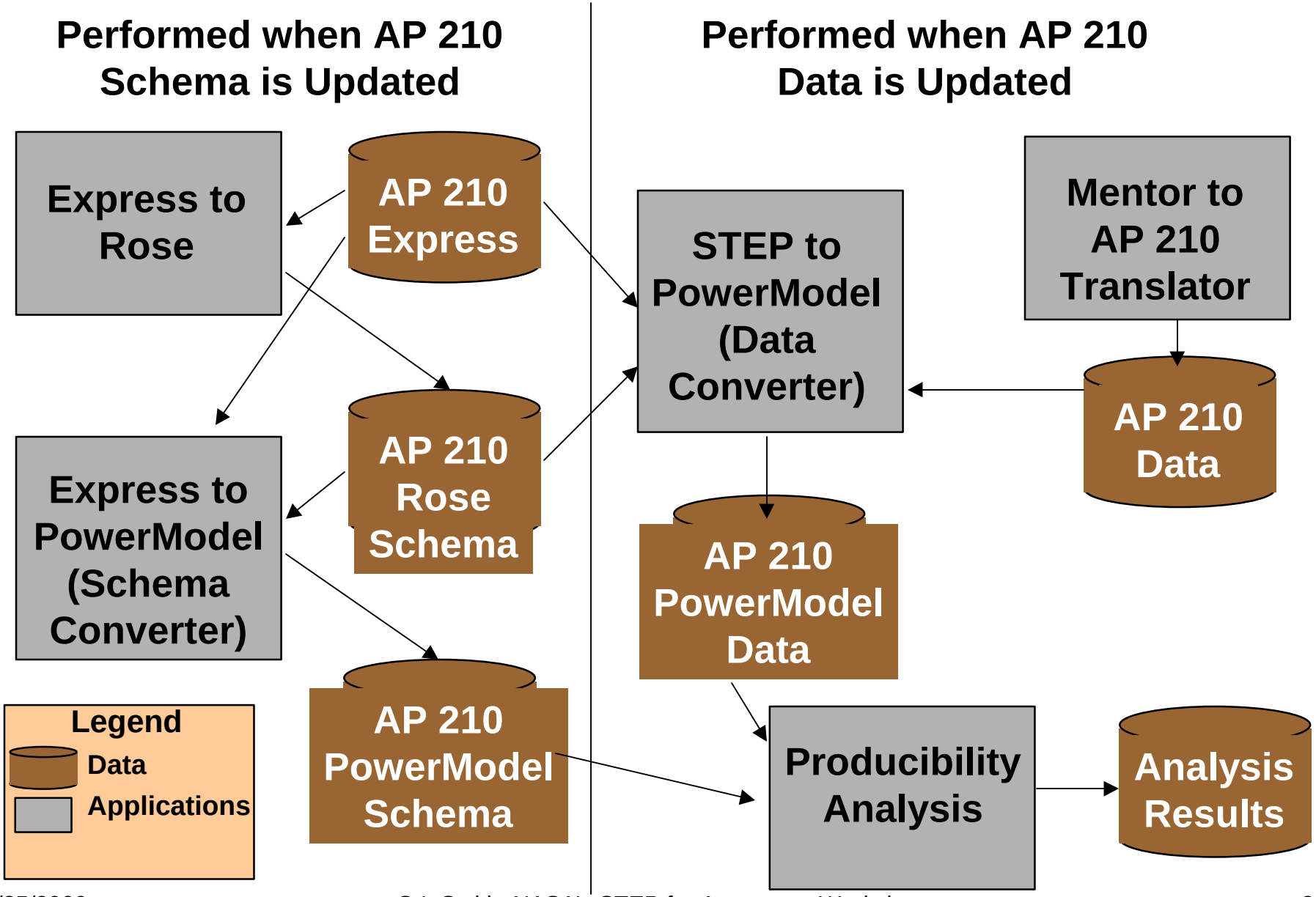
Objectives:

- **Deliver a new PWA producibility review process that enables review team member interaction with on-line tools and eliminates slow paper flow times.**
- **Improve product quality and cost by reducing first-design release rejections through identification of producibility issues earlier in the PWA development cycle.**

Approach:

- **Apply team from Define, Produce, and Information Systems groups.**
- **Implement Manufacturing Resource Editor, Producibility Rules Facility, Negotiation Facility, and new producibility process. Validate process change results.**

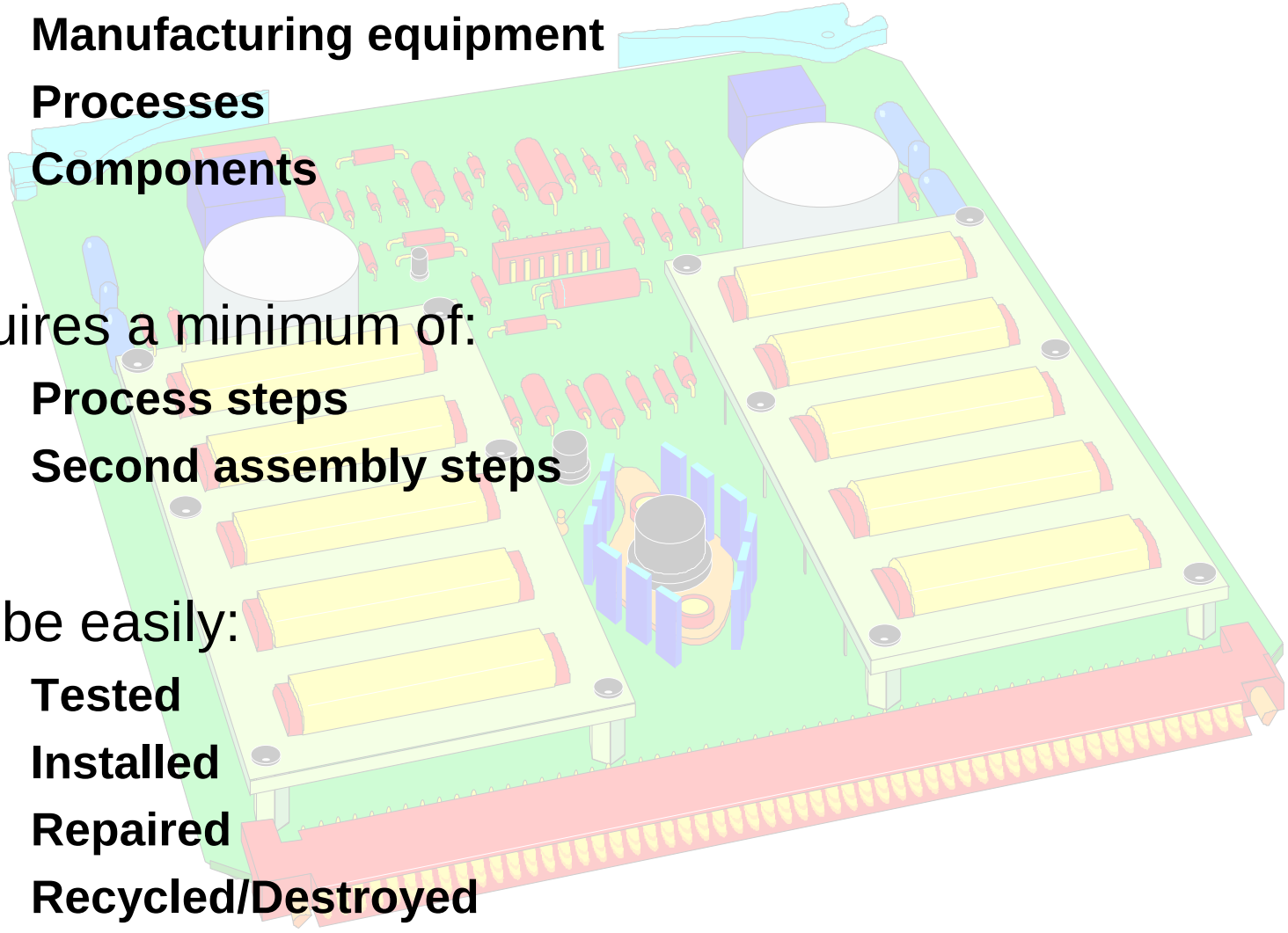
Producibility Schematic



What Makes PWA Designs Producible?

Can be built with available:

- **Manufacturing equipment**
- **Processes**
- **Components**



Requires a minimum of:

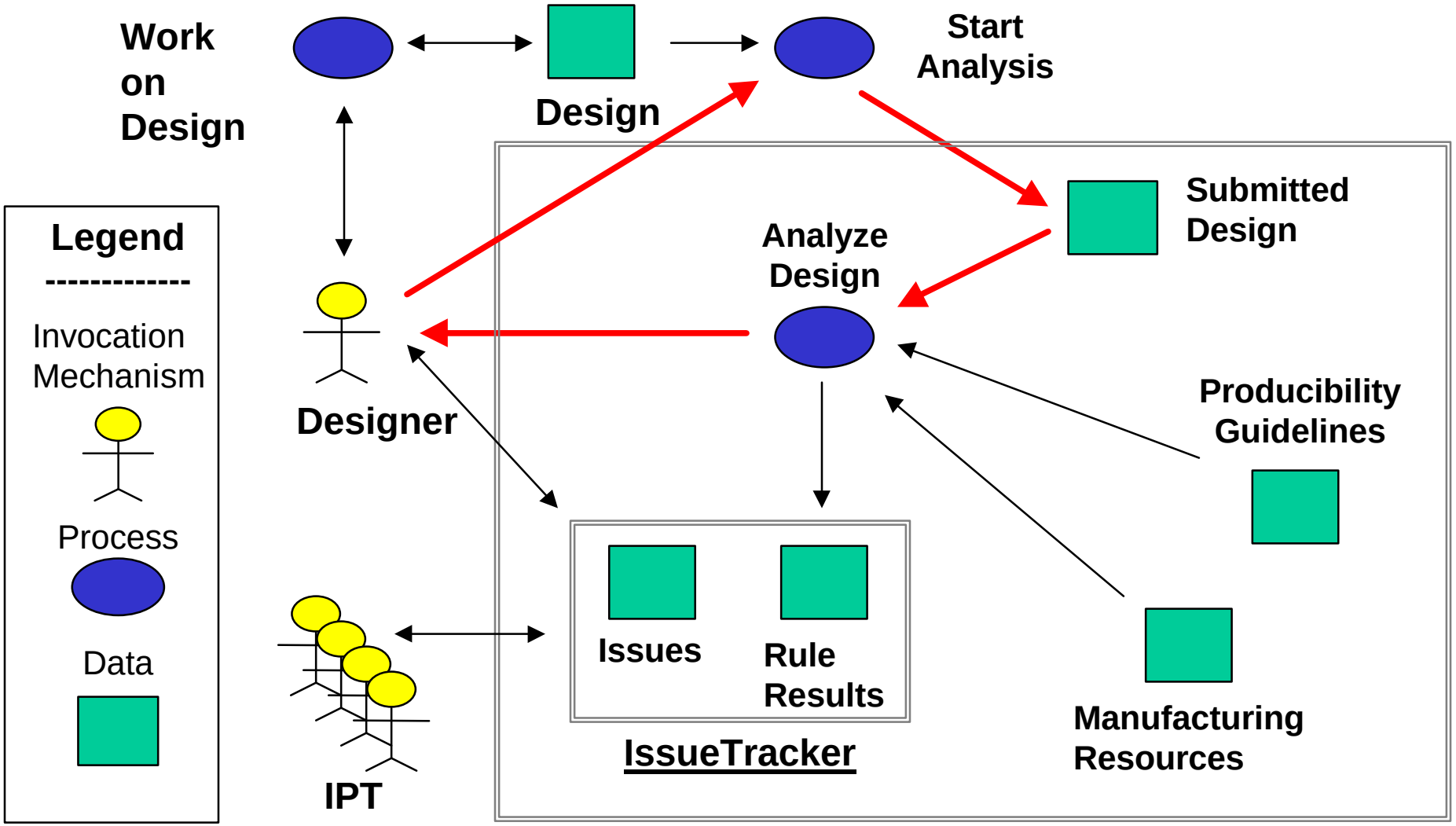
- **Process steps**
- **Second assembly steps**

Can be easily:

- **Tested**
- **Installed**
- **Repaired**
- **Recycled/Destroyed**

Producibility Analysis

New Process Data Flow

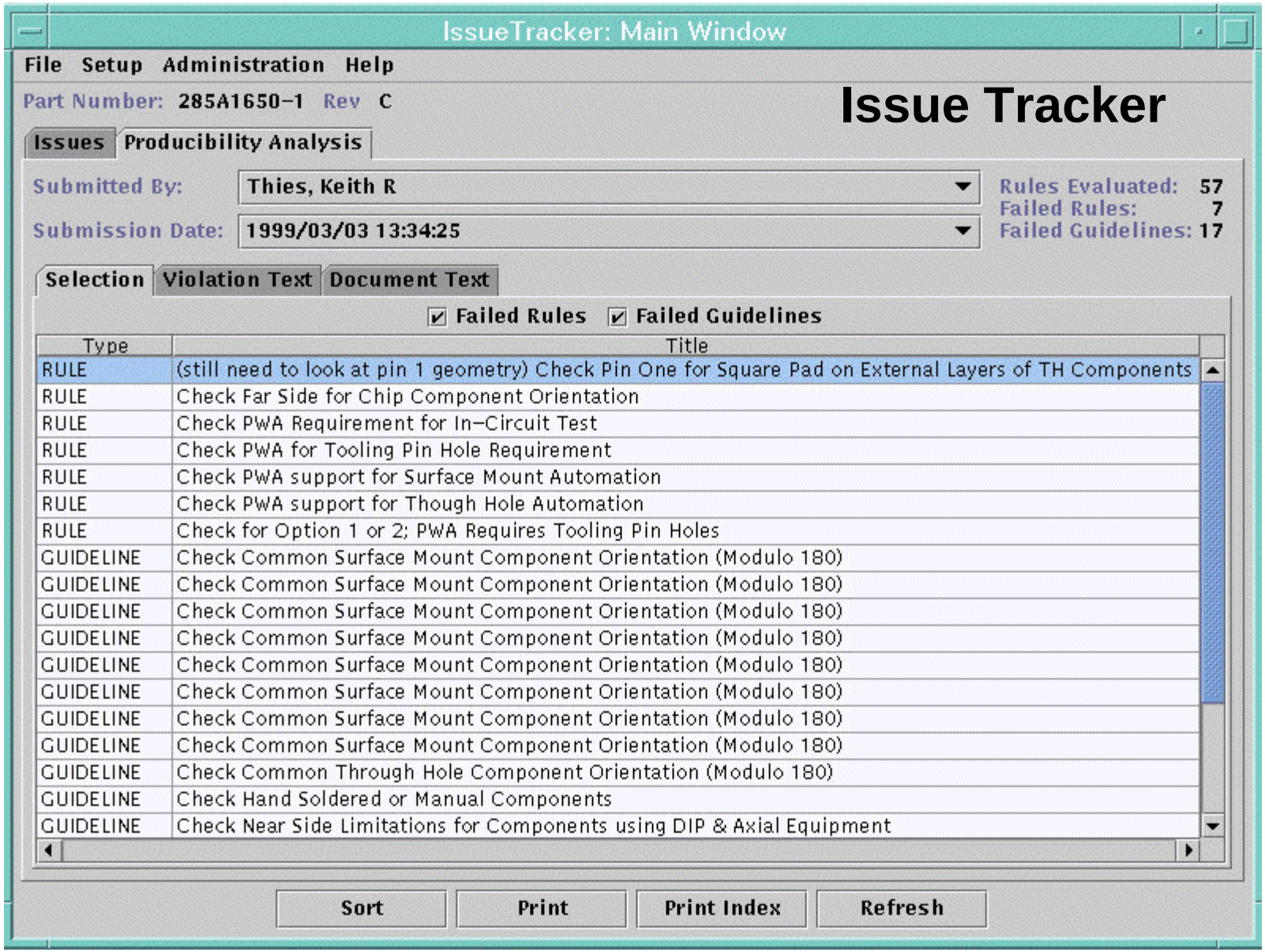


Producibility Analysis

Rule Summary Spreadsheet

Producibility Analysis for PWA:				B169-78762-4								
	PWA Description:			descriptio								
	PWA Revision:			0								
Analysis Summary:												
	Analysis Code:			09091998115546								
	Initiation Date & Time:			9/9/98	11:55:46							
	Completion Date & Time:			9/9/98	11:57:46							
	Individual Submitting Analysis			smithg								
	Rules Executed:			53								
	Possible Rule Violations:			6								
	Possible Guideline Violations:			6								
Document Legend:												
IPG	Irving Producibility Guidelines 201-1000-002, Rev E											
PLP	Part Library Procedures Manual, TBD											
Analysis Detail:												
Doc	**Doc Sec**	**R/G**	**P/F**	**Rule Num**	**Rule Ver**	**Rule Name**						
PLP	1.0	Guideline	**Fail**	Rule213	202.12	Check Component Surface Placement vs Part Surface Constraints						
IPG	3.2.2	Guideline	**Pass**	Rule130	807.47	Check PWA Layer Construction (Balanced Layers)						
IPG	3.2.2	Guideline	**Pass**	Rule111	382.47	Check PWA Layer Construction (Even Layers)						
IPG	3.2.6	Rule	**Pass**	Rule146	171.10	Check PWA for Connectors on Both Sides						
IPG	3.2.7	Rule	**Pass**	Rule42	355.40	Check Ground Plane Position						
IPG	3.2.7	Rule	**Pass**	Rule36	342.39	Check Power Plane Position						
IPG	3.2.9	Rule	**Pass**	Rule24	217.36	Check Minimum PWB Dimensions to Determine Tooling Strip Use						
IPG	3.2.9	Rule	**Fail**	Rule12	249.38	Check Minimum PWB Dimensions for Wave Solder equipment						
IPG	3.2.9	Rule	**Pass**	Rule10	212.36	Check Maximum PWB Dimensions for Wave Solder equipment						
IPG	3.2.9	Rule	**Pass**	Rule9	225.42	Check Maximum PWB Dimensions for Surface Mount equipment						
IPG	3.2.9	Rule	**Pass**	Rule7	231.36	Check Minimum PWB Dimensions for Surface Mount equipment						
IPG	3.3.1	Rule	**Pass**	Rule174	183.17	Check PWA support for Though Hole Automation						
IPG	3.3.2	Rule	**Fail**	Rule176	147.25	Check PWA Requirement for In-Circuit Test						
IPG	3.3.4	Rule	**Fail**	Rule175	180.19	Check PWA support for Surface Mount Automation						
IPG	3.4.1	Rule	**Pass**	Rule154	569.28	Check Far Side Limitations for Dual Vapor Phase Solder Components						

Producibility Analysis



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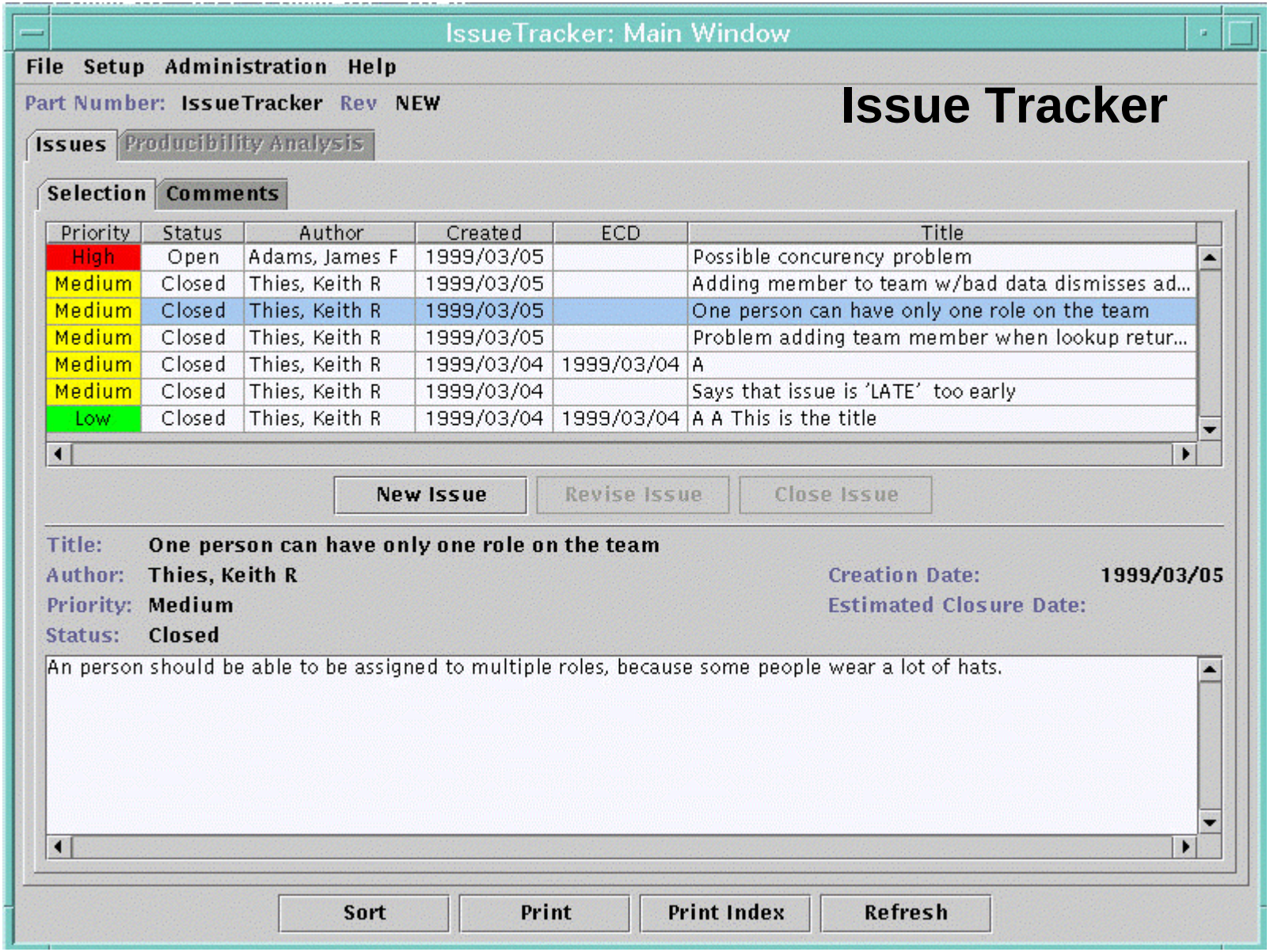
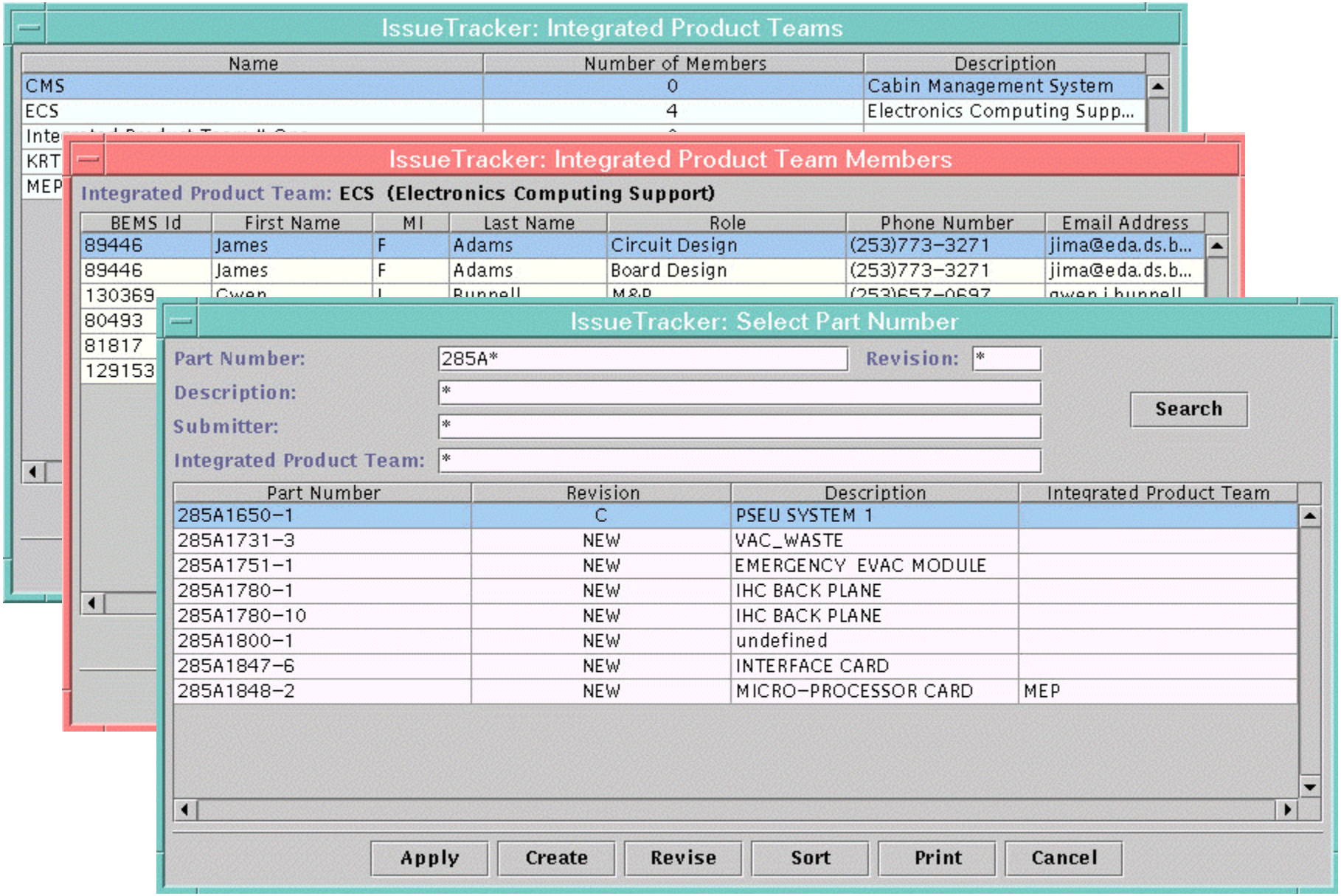


Producibility Analysis



Producibility Analysis

Implementation Phases

Prototype (3/98 - 9/98)	Evaluation (12/98 - 6/99)	Production (6/99 -)
• Target: Irving • Developmental AP 210 Translator • Limited Issue Tracker capability • Limited rule set • Completed 9/30	• Target: EP • ITI Version A AP 210 Translator • Enhanced Issue Tracker capability • Enhanced rule set • Initiated 12/11	• Target: Boeing • ITI Version B AP 210 Translator • Full Issue Tracker capability • Full rule set • Extend into: • **Testability Analysis** • **Design Analysis** • **Library Verification**

Producibility Analysis

Benefits:

- **Less rework**
- **Fewer design iterations**
- **Reduced burden on producibility reviewers**

Targeted Application:

- **Electronics Products organization**
- **Irving & El Paso, TX PWA Facilities**

Technology Available:

- **October 1998**

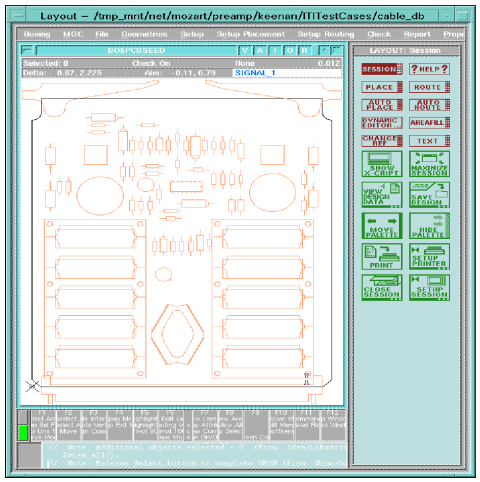
Expected Savings When Implemented on Target Application:

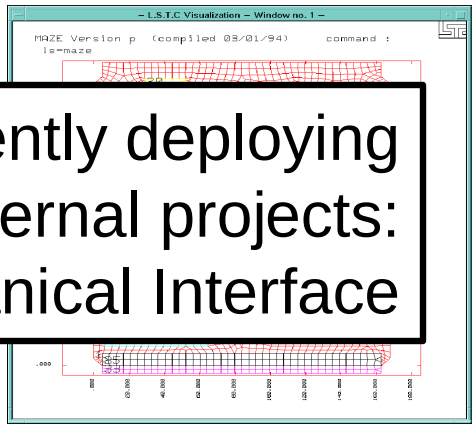
- **1500 to 3000 hours per year***

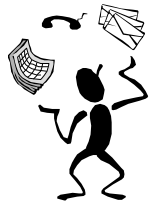
***Estimate only - Boeing is not to be contractually held to this number!**

Boeing - STEP for Electronics

Space & Communications — *Electronics Computing Support*







Boeing is presently deploying AP 210 on several internal projects:
- Electrical Mechanical Interface

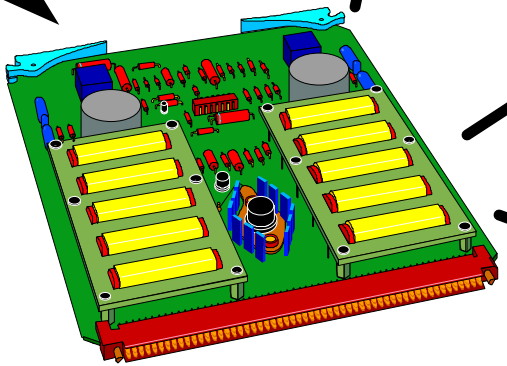
Design

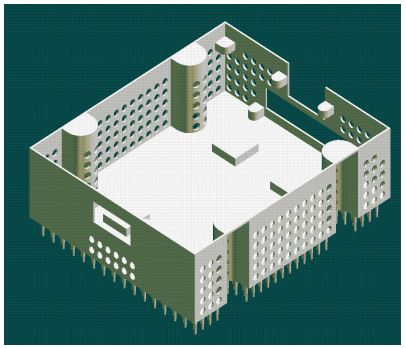
Mentor To/From AP 210

AP 210 To Producibility Analysis

AP 210 To Durability Analysis

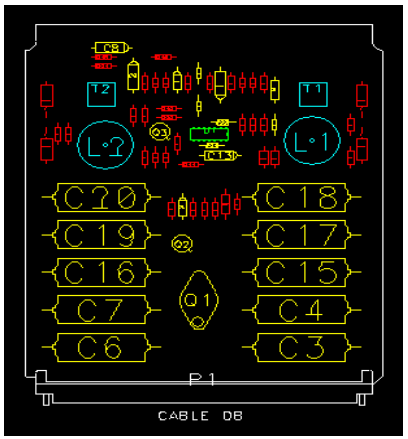
Analysis





AP 210 To/From Mechanical

Future



AP 210

Mechanical

Manufacturing

Electrical Mechanical Interface

Objectives:

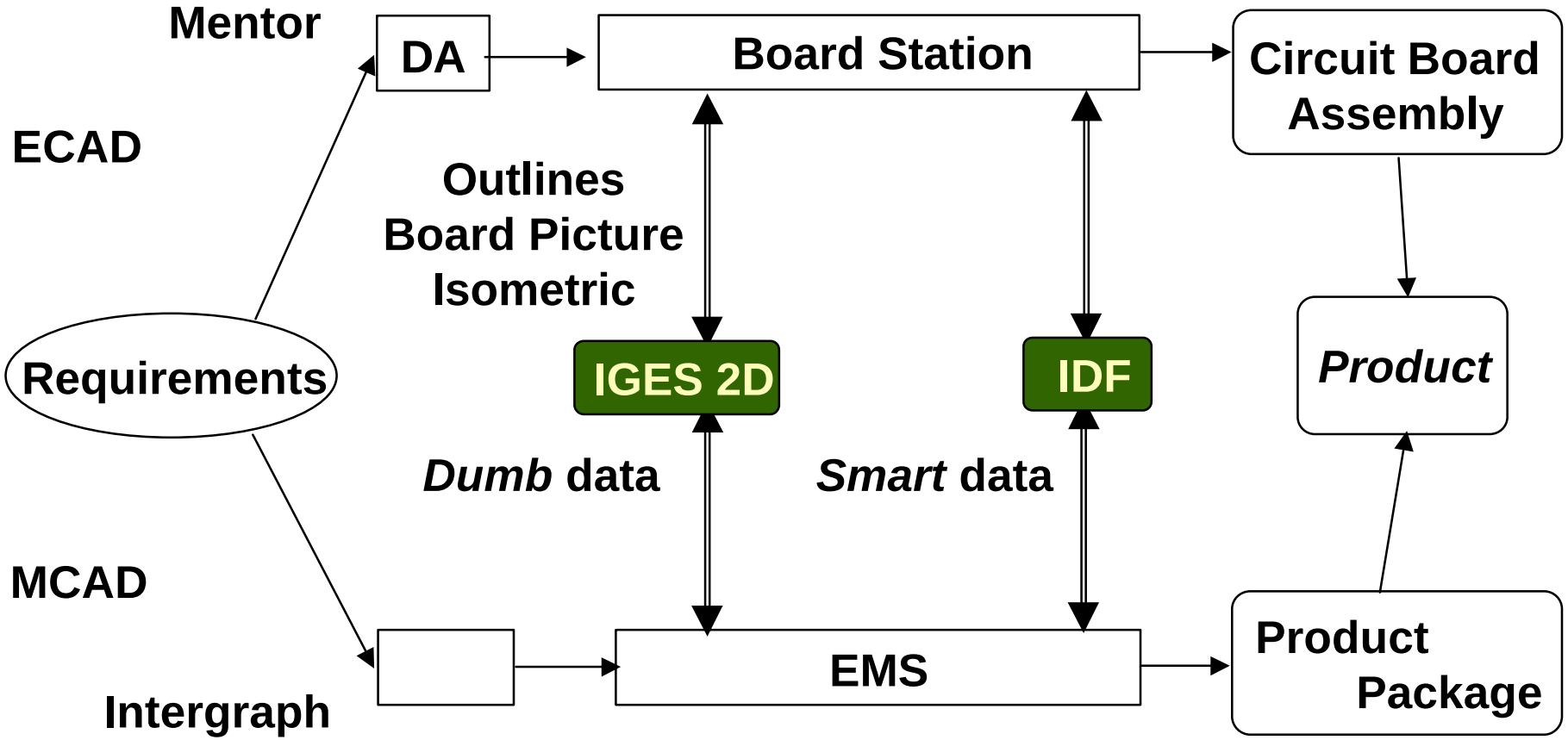
- **Integrate electrical PWA design with mechanical enclosure design to improve quality and reduce flow time.**
- **Implement a bi-directional exchange of electrical (electronic) and mechanical product and packaging information for PWAs using the STEP standard.**
- **Establish data exchange repository and configuration management process.**

Approach:

- **Replace the existing proprietary exchange format (IDF) with a broader international standard (STEP) to allow the exchange of additional information.**
- **Migrate mechanical and electrical converters to commercial translators.**
- **Provide prototype to support electronic and mechanical products developed in Electronic Products design centers.**

Electrical Mechanical Interface

Mentor Version 8 Design Process



Exchange of data is performed using IGES or/and IDF. IDF is company proprietary.

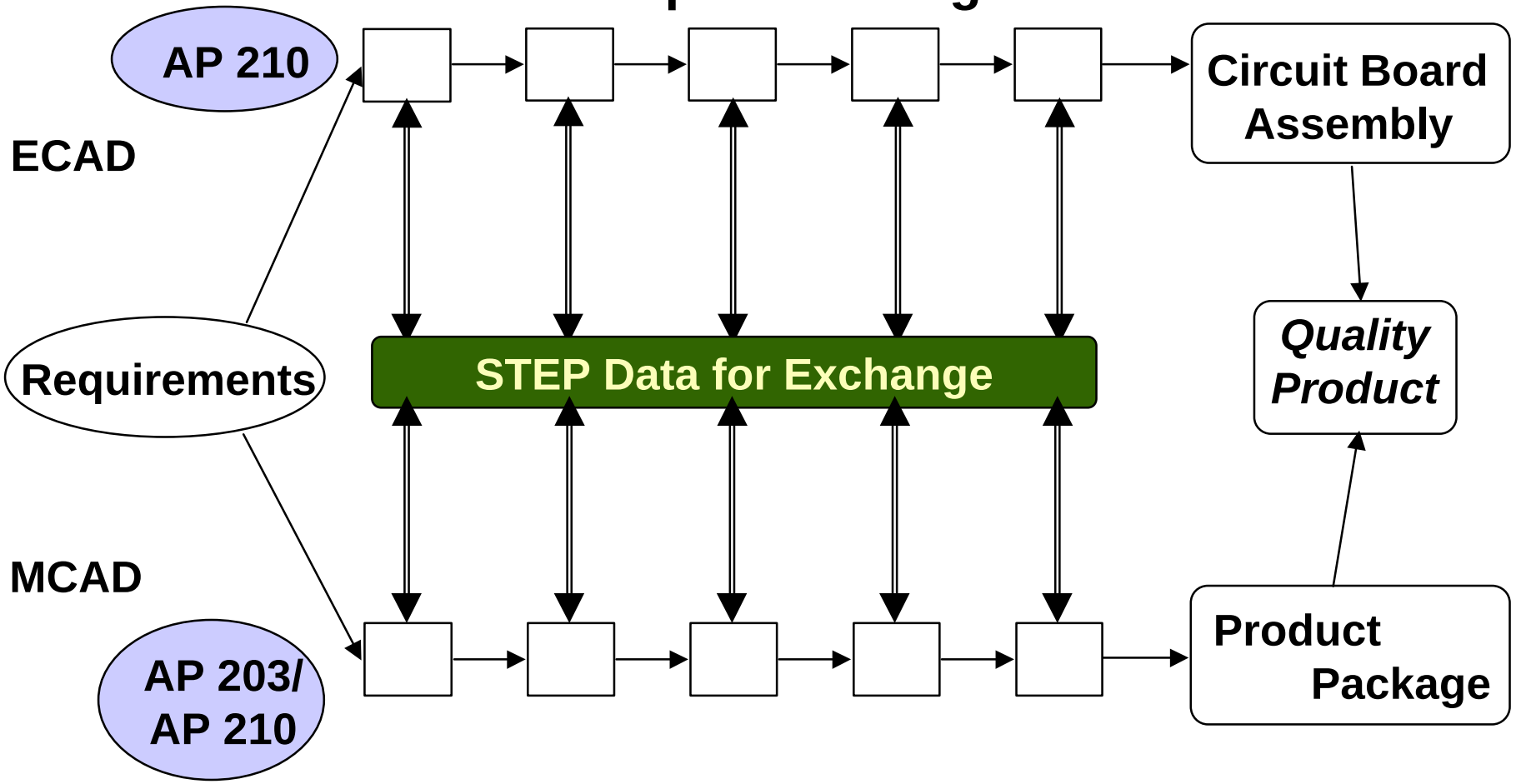
Electrical Mechanical Interface

Concerns with Current Process

- Exchange format is vendor proprietary.
- Existing problems with IDF translators - replacing complex object with primitives, loss of data intelligence, font changes.
- The transfer of data back to Electrical system from Mechanical system is incomplete.
- No association between systems - a change on one system is not reflected in the other.
- No mechanism to provide configuration management.

Electrical Mechanical Interface

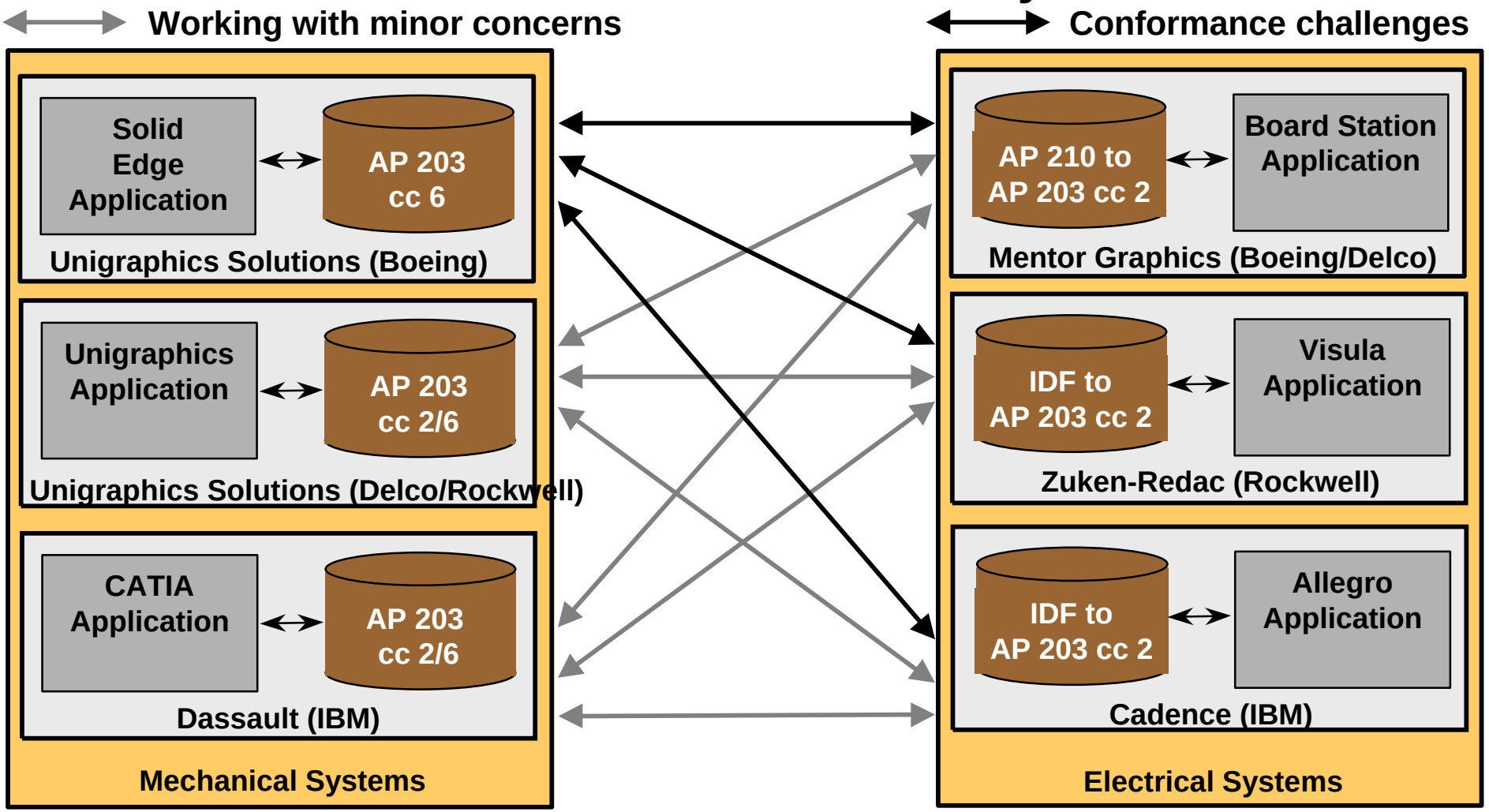
Proposed Design Process



Exchange of data independent of process or tools. Frequency controlled by unique Business needs. Exchange of *intelligent* data.

Electrical Mechanical Interface

Data Transfer Between Systems

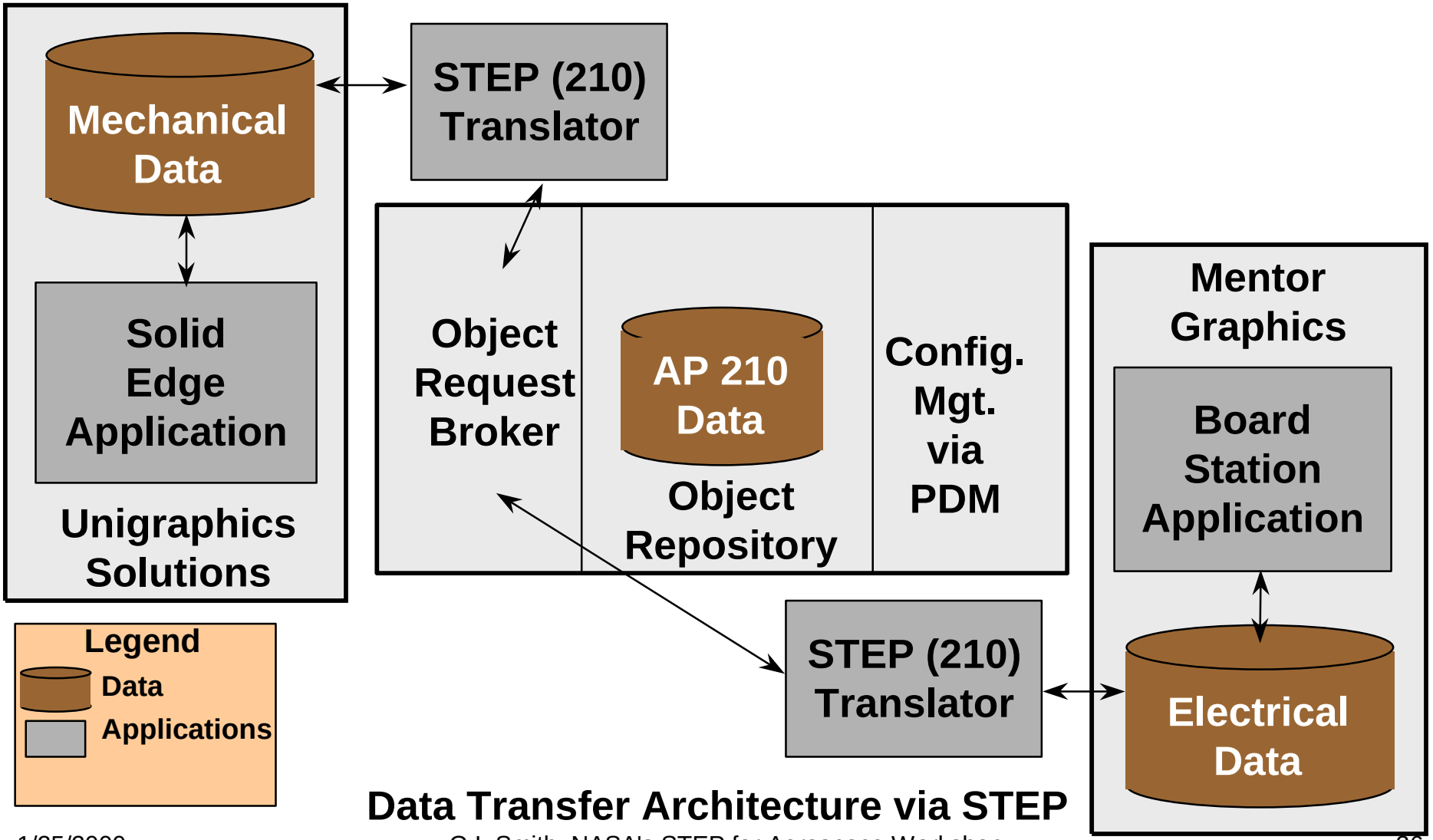


AP 203 cc 2 - Geometrically Bounded Wireframe Models, Surface Models or Both (AP 210 cc 15)

AP 203 cc 6 - Advanced B-Rep (AP 210 cc 17)

Electrical Mechanical Interface

Proposed Final Architecture



Data Transfer Architecture via STEP

Electrical Mechanical Interface

Benefits:

- **Error reductions, elimination of duplicate data entry.**
- **Improved quality and flow time, reduce design iterations due to errors.**
- **Concurrent Engineering by allowing flow of data between electrical/mechanical systems.**

Targeted Application:

- **Numerous Boeing projects**

Technology Available:

- **June 1999**

Expected Savings When Implemented on Target Application:

- **2000 engineering hours per year***

***Estimate only - Boeing is not to be contractually held to this number!**

Boeing - STEP for Electronics

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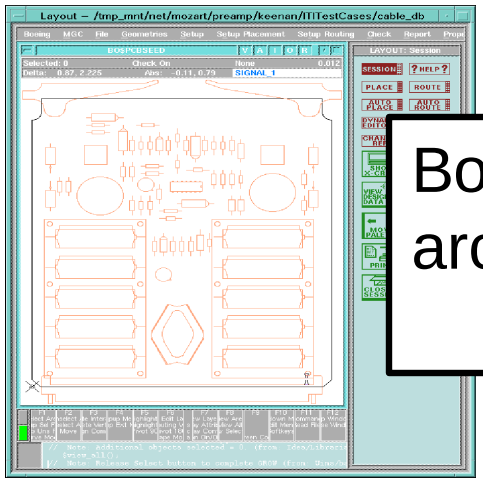
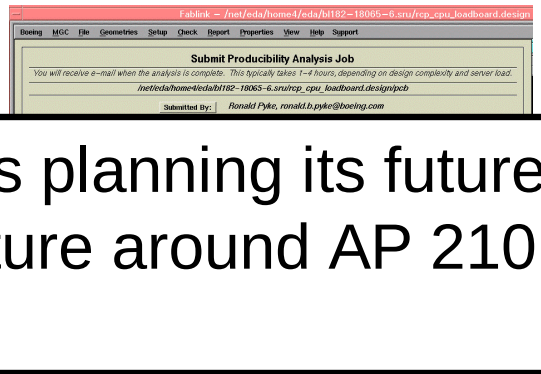
Boeing is planning its future architecture around AP 210!



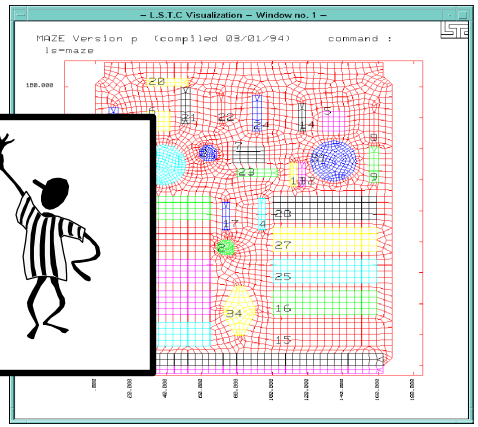
Design

Mentor To/From AP 210

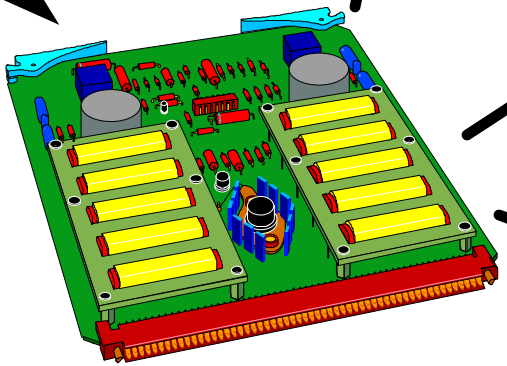
AP 210 To Producibility Analysis



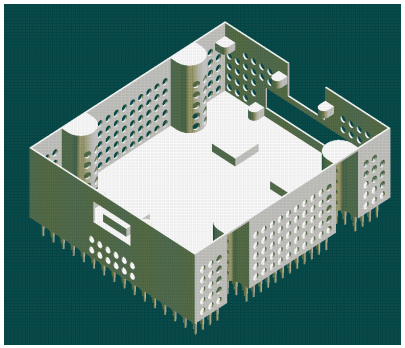
AP 210 To Durability Analysis



Analysis



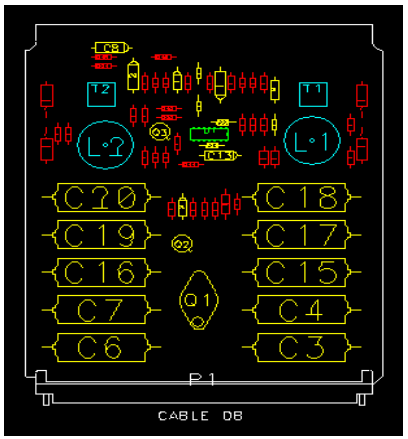
AP 210



AP 210 To/From Mechanical

Mechanical

Future

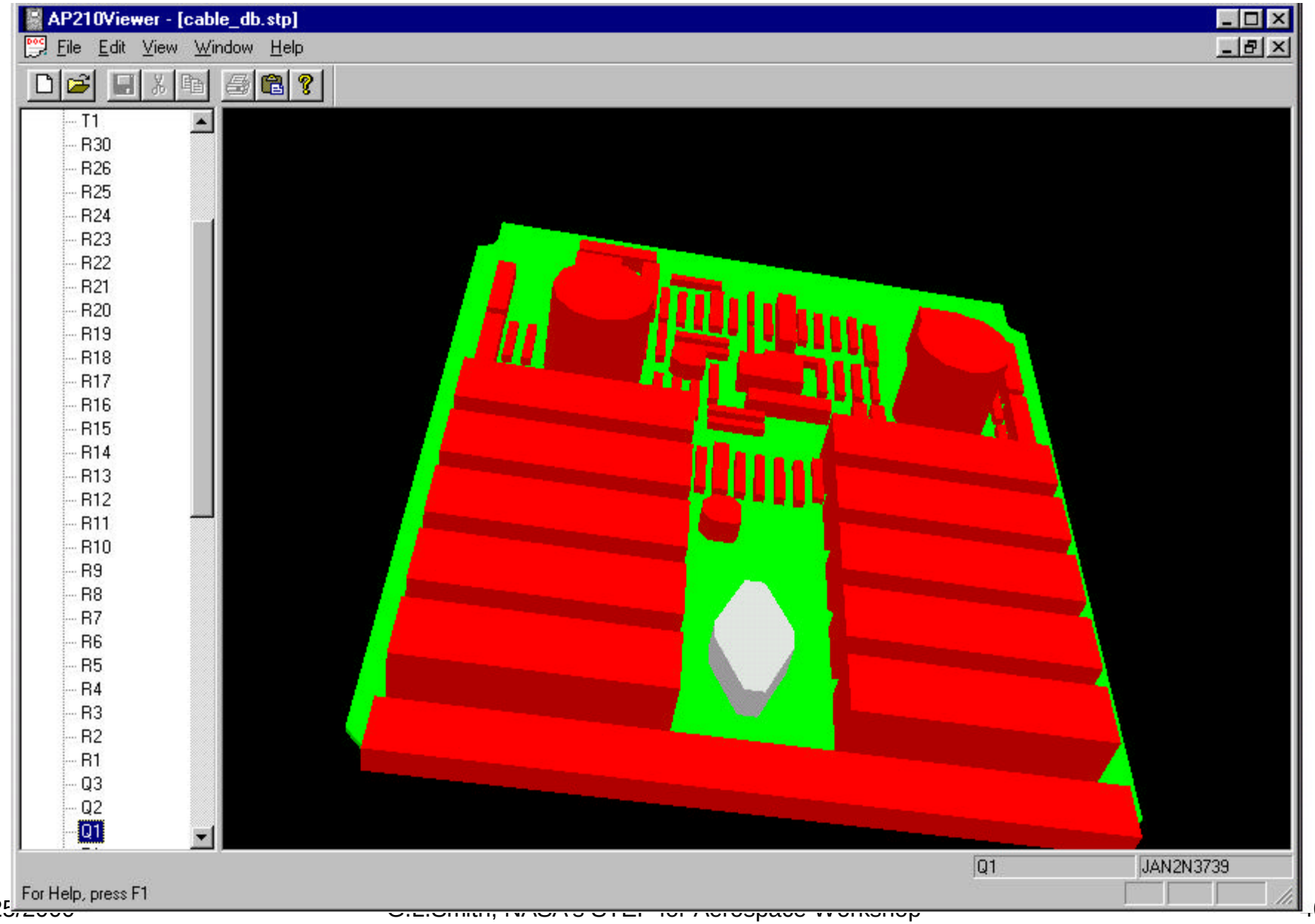


Manufacturing

AP 210 Modularization

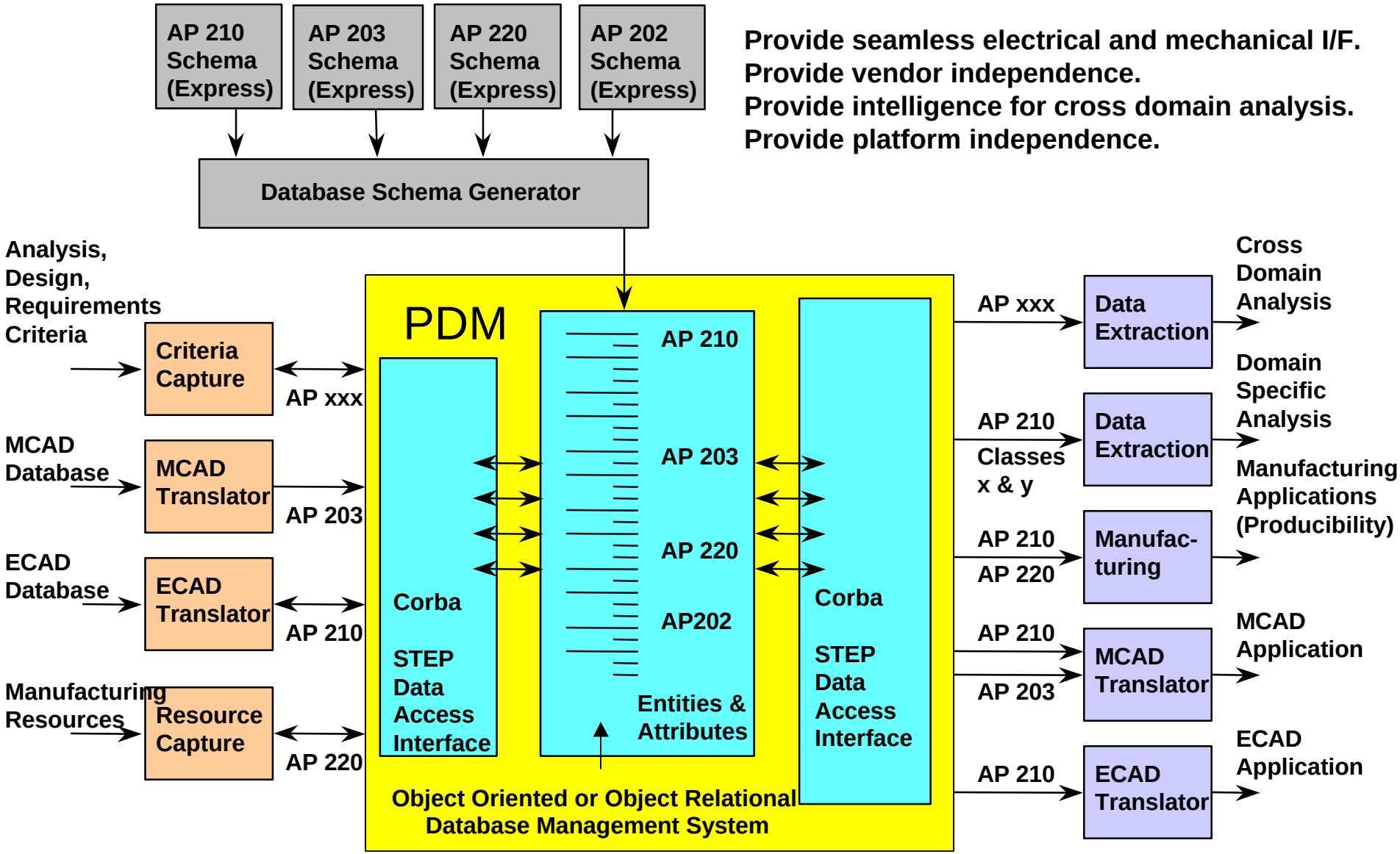
- Supporting PDES, Inc. STEP modularization activity.
- Developing Statement of Work / Direction.
- Identifying useful areas for the module creation supporting:
  - **Customers**
    - **Design**
    - **Fabrication**
  - **Other standards**
    - **IDF**
    - **GenCAM**
    - **EDIF**
    - **others as required**
  - **Ongoing internal projects**
- Supporting interoperability with other APs.

AP 210 PWA Viewer



PWA/PWB Inwork Design Repository

Space & Communications — *Electronics Computing Support*



Challenges

Data Acquisition Challenges:

- **Acquiring complete PWA/PWB data in the form of STEP AP 210 (many translators):**
  - **CD Translator (PreAmp - 96)**
  - **DIS WD1 Translator (TIGER - 97)**
  - **DIS Translators, (ITI)**
- **Expanding STEP data for end users.**
- **Identifying what STEP data is missing.**
- **Extracting specific STEP data.**

Performance Challenges:

- **Loading hundreds of thousands of objects into object systems (STEP AP 210 data).**

Challenges

Cultural Challenges:

- **Educating the community about AP 210 and its advantages.**
- **Enhancing the current process of human inspection with process automation analysis and information capture.**

Configuration Challenges:

- **Provide a configuration and management environment to create and modify rules.**
- **Providing a intuitive methodology for individuals to write producibility rules:**
  - **Administration rules**
  - **Data Extraction/Verification rules**
  - **Data Analysis rules**

Summary

- Boeing has been working on AP 210 since its inception.
- Boeing is supporting the development of AP 210 translation:
  - Mentor to/from AP 210
- Boeing is presently deploying AP 210 on several projects:
  - Durability Analysis
  - Producibility Analysis
  - Electrical Mechanical Interface
  - AP 210 Viewer
- Boeing is planning its future architecture around AP 210.
- Boeing has invested extensively (time and money) in AP 210 development and implementation.

STEP for Electronics is available and a viable standard for Product Data Exchange!

For More Information

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